A SOUTHERN CALIFORNIA PERSPECTIVE OF THE APRIL, 1998 TRANS-PACIFIC ASIAN DUST EVENT

David M. Tratt
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109-8099

Robert J. Frouin
Scripps Institution of Oceanography
University of California, San Diego
9500 Gilman Drive
La Jolla, CA 92093-0221

Douglas L. Westphal
Marine Meteorology Division
Naval Research Laboratory
7 Grace Hopper Avenue
Monterey, CA 93943-5502

The Jet Propulsion Laboratory (JPL) **coherent CO_2 backscatter lidar** has been in almost continuous operation since 1984 and has now accumulated a significant time-series database tracking the long-term and seasonal variability of backscatter from the atmospheric column above the Pasadena, Calif. locale (Tratt and Menzies, 1994). A particularly noteworthy episode observed by the lidar in 1998 was a particularly extreme instance of incursion by **Asian-sourced dust** during the closing days of April. Such events are not uncommon during the northern spring, when strong cold fronts and convection over the Asian interior deserts loft crustal material into the mid-troposphere whence it can be transported across the Pacific Ocean, occasionally reaching the continental US. However, the abnormal strength of the initiating storm in this case generated an atypically dense cloud of material which resulted in dramatically reduced visibility along the length of the Western Seaboard. These dust events are now recognized as a potentially significant, non-negligible radiative forcing influence (Parungo *et al.*, 1994).

The progress of the April 1998 dust cloud eastward across the Pacific Ocean was initially observed in satellite imagery and transmitted to the broader atmospheric research community *via* electronic communications. The use of Internet technology in this way was effective in facilitating a rapid response correlative measurement exercise by numerous atmospheric observation stations throughout the western US and its success has resulted in the subsequent establishment of an *ad hoc* communications environment, data exchange medium, and mechanism for providing early-warning alert of other significant atmospheric phenomena in the future (Husar *et al.*, 1998).

The first lidar observations of the extreme Asian dust event made from the JPL site (34° 12' N; 118° 10' W; 390 m MSL) were acquired on April 27, 1998. Its evolution was tracked by the lidar throughout that entire week, and was well advanced into the dissipation phase when the onset of stormy conditions on May 2, which persisted into the following week, obscured the final decay stages. Near-concurrent measurements of atmospheric optical depth were also recorded during this same interval by an autonomous sun-sky scanning spectral radiometer stationed on San Nicolas Island off the California coast at geographical coordinates: 33°15' N, 119°29' W, 133 m MSL. This dataset recorded a significant increase in atmospheric optical depth on April 25 over San Nicolas which slowly diminished over the following 5 days (Fig. 1). These data also yield retrievals of aerosol size distribution which may be used to cross-validate grosser features of the lidar soundings (see Fig. 2).

Ex post facto analysis of the event using the US Navy Aerosol Analysis and Prediction System (NAAPS, Westphal *et al.*, 1998) accurately hindcasted arrival of the dust cloud in the Los Angeles region on April 25-27, although the simulation matrix has insufficient resolution to maintain the vertical structure of the dust as revealed by the lidar profiles. Figure 3 shows the development of the dust cloud above the JPL lidar site through the height of the event, as modeled using NAAPS.

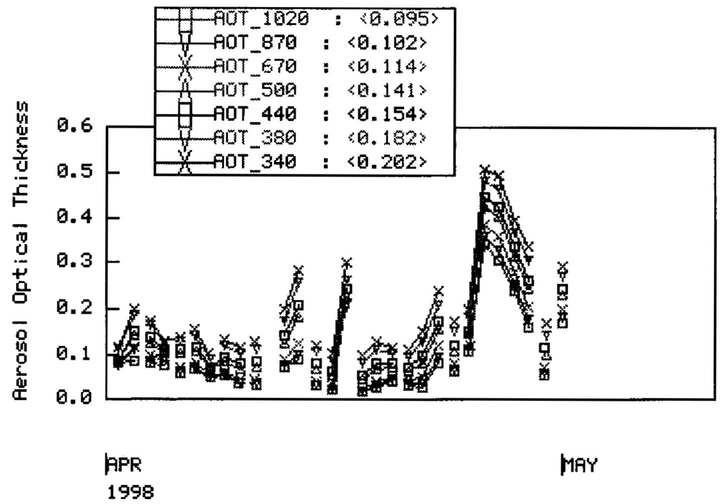

Figure 1. Aerosol optical thickness (AOT) time-series above San Nicolas Is., Calif. recorded with a spectrally scanning sunphotometer for the time period containing the dust event. The sharp increase in AOT toward the end of April marks the first arrival of the dust cloud in the region on April 25.

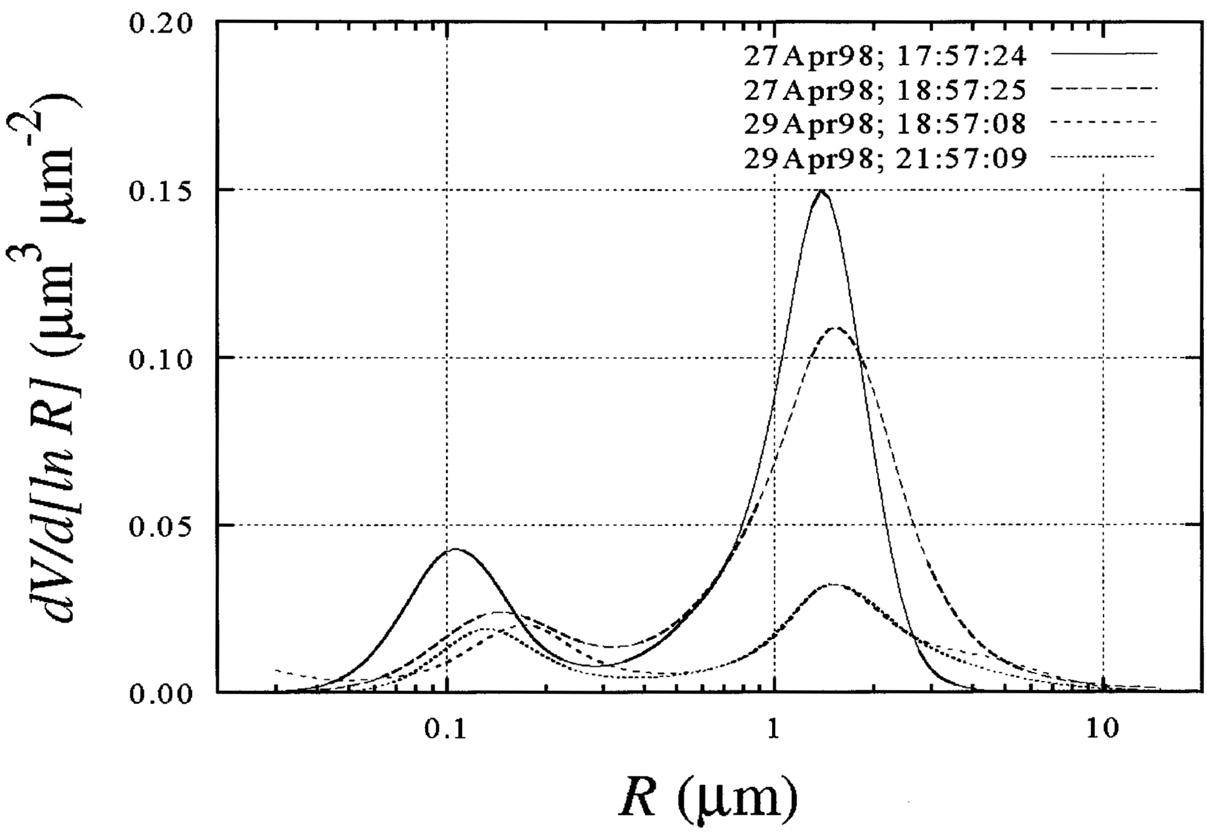

Figure 2. Retrieved column-integrated aerosol volume size distributions (particle radius R) above San Nicolas Is., Calif. corresponding to four different time intervals within the dust event.

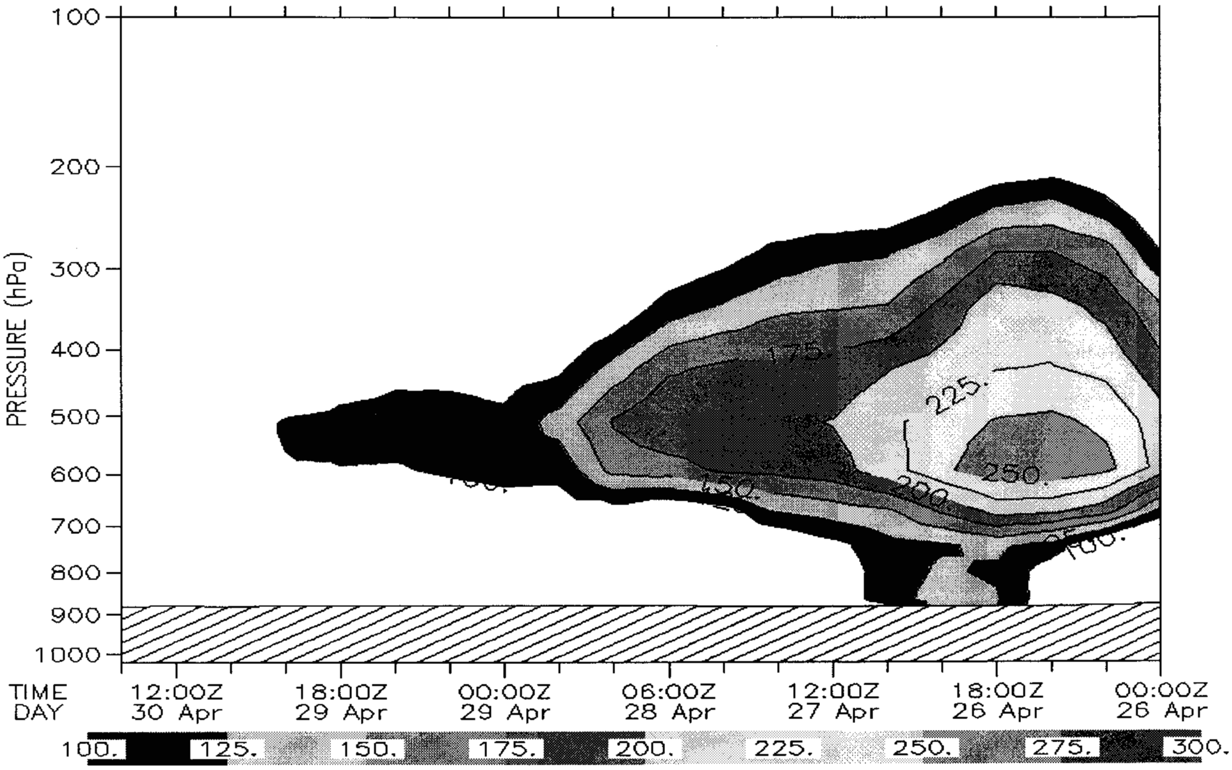

Figure 3. Modeled time-series dust concentration above Pasadena, Calif. for the period 26-30 April, 1998. Gray-scale contours represent mass density expressed in $\mu g\ m^{-3}$.

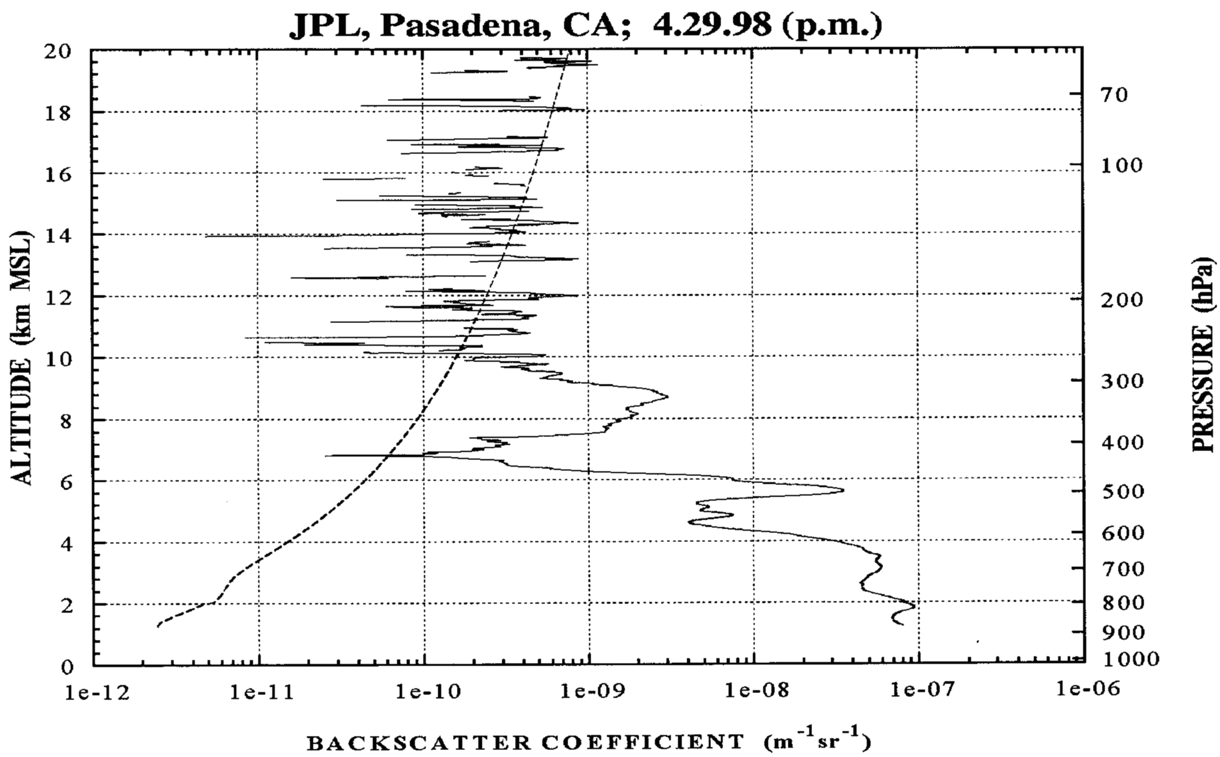

Figure 4. Vertically-resolved backscatter at the 10.6-μm JPL lidar operating wavelength acquired on May 29, 1998, at around 22:00 UTC. (The broken curve denotes the system sensitivity.)

For comparison, Figure 4 shows the JPL lidar profile obtained on the afternoon of April 29, 1998 at approximately 22:00 UTC. The thin strongly-scattering layer encountered at ~5.5 km MSL corresponds to the modeled centroid of the dust cloud, which appears at the 550 mbar level in the NAAPS simulation (Fig. 3). Although the elevated feature centered near 8.5 km MSL in Fig. 4 does not appear in the NAAPS simulation, air parcel back-trajectory analyses from this altitude zone flowed back to the dust generating region of China in 9-10 days (Fig. 5), coinciding with the passage through that region on April 19 of a rapidly moving shallow trough which, through analysis of surface observations and satellite imagery, has been identified as the chief progenitor of the eastward-transported dust (Westphal *et al.*, 1998).

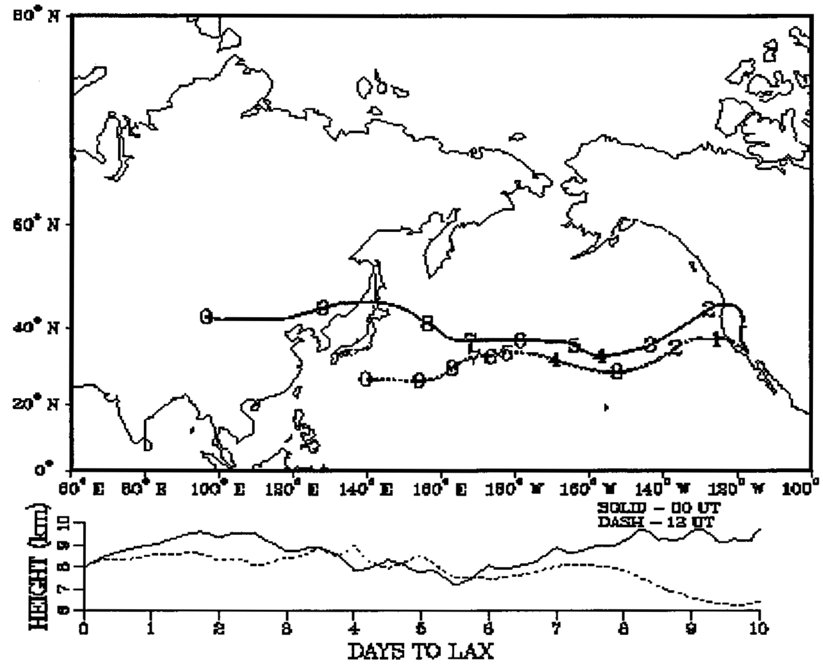

Figure 5. Air-parcel backtrajectory analysis from the 8-km MSL altitude level above the Los Angeles area on April 29, 1998.

Acknowledgments

Portions of this work were carried out by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration (NASA). The support of the Office of Naval Research and the Naval Research Laboratory through programs PE-0602435N and PE-06-1153 is gratefully acknowledged. O. Dubovik and A. Smirnov of the NASA Goddard Space Flight Center AERONET team are gratefully acknowledged for provision and validation of aerosol size distribution retrievals. Air-parcel backtrajectory analyses were provided by R. Schnell and J. Harris at the NOAA Climate Monitoring and Diagnostics Laboratory.

References

Husar, R. B., *et al.*, 1998: *http://capita.wustl.edu/Asia-FarEast/*

Parungo, F., Z. Li, X. Li, D. Yang, and J. Harris, 1994: Gobi dust storms and The Great Green Wall. *Geophys. Res. Lett.*, **21**(11), 999-1002.

Tratt, D. M., and R. T. Menzies, 1994: Recent climatological trends in atmospheric aerosol backscatter derived from the Jet Propulsion Laboratory multiyear backscatter profile database. *Appl. Opt.*, **33**(3), 424-430.

Westphal, D. L., T. F. Hogan, and M. Liu, 1998: Dynamical Forcing of the Chinese Dust Storms of April 1998. Presented at the Fall Meeting of the American Geophysical Union, San Francisco, December 9-13, 1998.